Understanding Energy Consumption Behavior in a Landlord-Tenant Context: What Do the Numbers Tell Us?

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March 31, 2015

Split Incentives and the Landlord-Tenant Problem

Split incentives, landlord-tenant problem are "principal-agent" problems:

- Occur when a person or group (the agent) makes decisions on behalf of another person or group (the principal).
- If the principal has incomplete information about an action taken by the agent, the agent won't always act in the interests of the principal, even when both parties could benefit.
- This can lead to a market failure and lower than optimal well-being in the economy.

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Principal-agent problems can lead to over-consumption of energy

2 cases:

1. Landlord pays utility bills, tenants choose consumption levels.
   → Tenants don't face marginal/average cost of energy. Few incentives to conserve.

2. Tenant pays for energy, cannot perfectly observe energy efficiency (EE) choices made by landlord.
   → Landlords have few incentives to invest in EE if costs cannot be recouped through higher rents.

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Split Incentives and the Landlord-Tenant Problem

Note: case 2 is conditional on tenants not being willing to pay a premium for energy efficiency

2 hypotheses follow from the second case:

i. When tenants pay for utilities you won't observe a rent premium for E.E. in similar buildings that differ only in their E.E. characteristics.

ii. If that's the case, landlords/owners won't be able to recoup their initial investment cost, so will (for example) purchase lower cost, low efficiency appliances.

Market Failure and Optimal Policy Response

- Optimal policy depends on type of market failure(s) at play

- Energy policy interventions affecting buildings:
  i. Carbon pricing
  ii. Mandatory energy standards
  iii. Voluntary labeling (e.g., Energy Star)

Split Incentives, Market Failure and Optimal Policy Response

Robert Stavins, Harvard Kennedy School:

"Price signals provided by a national cap-and-trade system are necessary to meaningfully address climate change at sensible cost, but such price signals are not sufficient. Other market failures call for supplementary policies. Take, for example, the principal-agent problem through which...both landlords and tenants lack incentives to make economically-efficient energy-conservation investments, such as installing thermal insulation."

Empirical evidence: Residential sector

"Energy use by apartment tenants when landlords pay for utilities," Levinson and Niemann, Resource and Energy Economics (2004)

- Utilities-included apartment dwellers set thermostats 1-3 degrees Fahrenheit warmer in winter
- Implies a 0.5%-0.75% increase in fuel expenditures.

Empirical evidence: Residential sector

"Split Incentives in Residential Energy Consumption," Gillingham, Harding and Rapson, Energy Journal (2012)

- Rented homes with utilities paid by tenants are less well insulated than owner-occupied homes.
- Tenants who pay for heat [AC] change their heat [AC] settings more often.
- Tenants who pay for heat keep their homes cooler at night.

Empirical evidence: Residential sector

"Are Renters Less Likely to Have Energy-Efficient Appliances?,"
Lucas Davis, "Design and Implementation of U.S. Climate Policy,"
Chicago Press (2012)

- Renters are less likely to have energy efficient refrigerators, clothes washers, dishwashers and lighting.

- Implies 9 trillion BTUs excess energy consumption annually in the US (0.5% of rental housing energy consumption).

Empirical evidence: Residential sector

"On the behavioral effects of residential electricity submetering in a heating season"
Gunay et al., Building and Environment (2014)

- Data from 40 households in Ottawa
- Tenants who paid for heat changed their heat setting more often.
- Tenants who did not pay for heat kept apartments 2 deg. C warmer.

Empirical evidence: Commercial sector

"Carbon emissions from the commercial building sector: The role of climate, quality, and incentives," Kahn, Kok and Quigley, Journal of Public Economics (2014)

- Data from commercial buildings in Sacramento, CA.
- Buildings with tenants who don't pay for utilities consume more electricity on hotter days.
- In buildings where tenants don't pay for electricity, energy consumption per square foot is higher by 11%.

Why study the commercial sector

Key considerations:

On one hand,

- → Extent of split incentive market failure may vary by sector
- → Commercial sector is 50%-70% multi-tenanted, so potentially large impact on energy consumption

On the other,

- → 'Green Leases' are becoming more common
- → Commercial contracts frequently undergo detailed negotiations about operating costs

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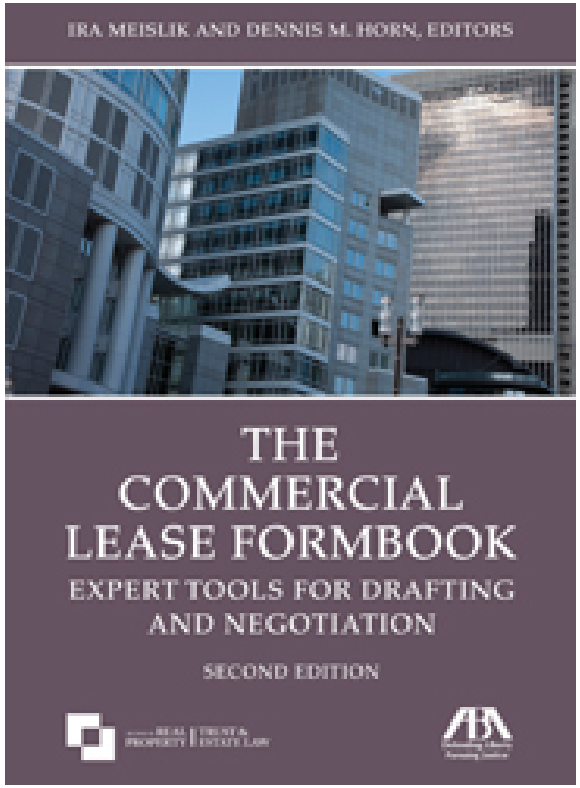
10 reasons you should have a green lease



"This commercial lease form library will help you negotiate the best provisions for your client. The book includes 27 complete commercial leases and lease-related forms with negotiation-focused commentary woven into the text of the lease."
American Bar Association, 2010, 750 pages.

My work

3 relevant projects:

1. Are prospective buyers and tenants willing to pay for a more energy efficient building?
2. Does an increase in "plus utilities" contracts across the U.S. reduce state-level commercial electricity consumption?
3. How do property management characteristics and "plus utilities" contracts interact together in determining electricity consumption?

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1. The Energy Efficiency Premium

Description

Newer, executive office centrally located on Edgewood Drive. Office features elegant reception area, three offices, plus one executive/conference room office downstairs, break room, large upstairs office, large storage room, and two restrooms.Stunning lake views from upstairs area! Energy efficient features will keep your electric costs low.

→ "Energy efficient features will keep your electric costs low"

Description

1st Floor - Executive Office Suites
Full Service
Single Office For Lease
High Visibility Location
Ample Parking
New Energy Efficient Building
Interior or Window Offices Available
Includes: Cherry wood flooring, upgraded carpet, 9ft ceilings, alarm system, upgraded kitchen, conference room w/ furniture

→ "New Energy Efficient Building"

1. The Energy Efficiency Premium

Tenants may be willing to pay a rent premium

- To obtain lower utility bills
- To mitigate cost impact of future energy price increases

Buyers may be willing to pay a selling price premium

- To obtain lower utility bills
- To obtain higher rents

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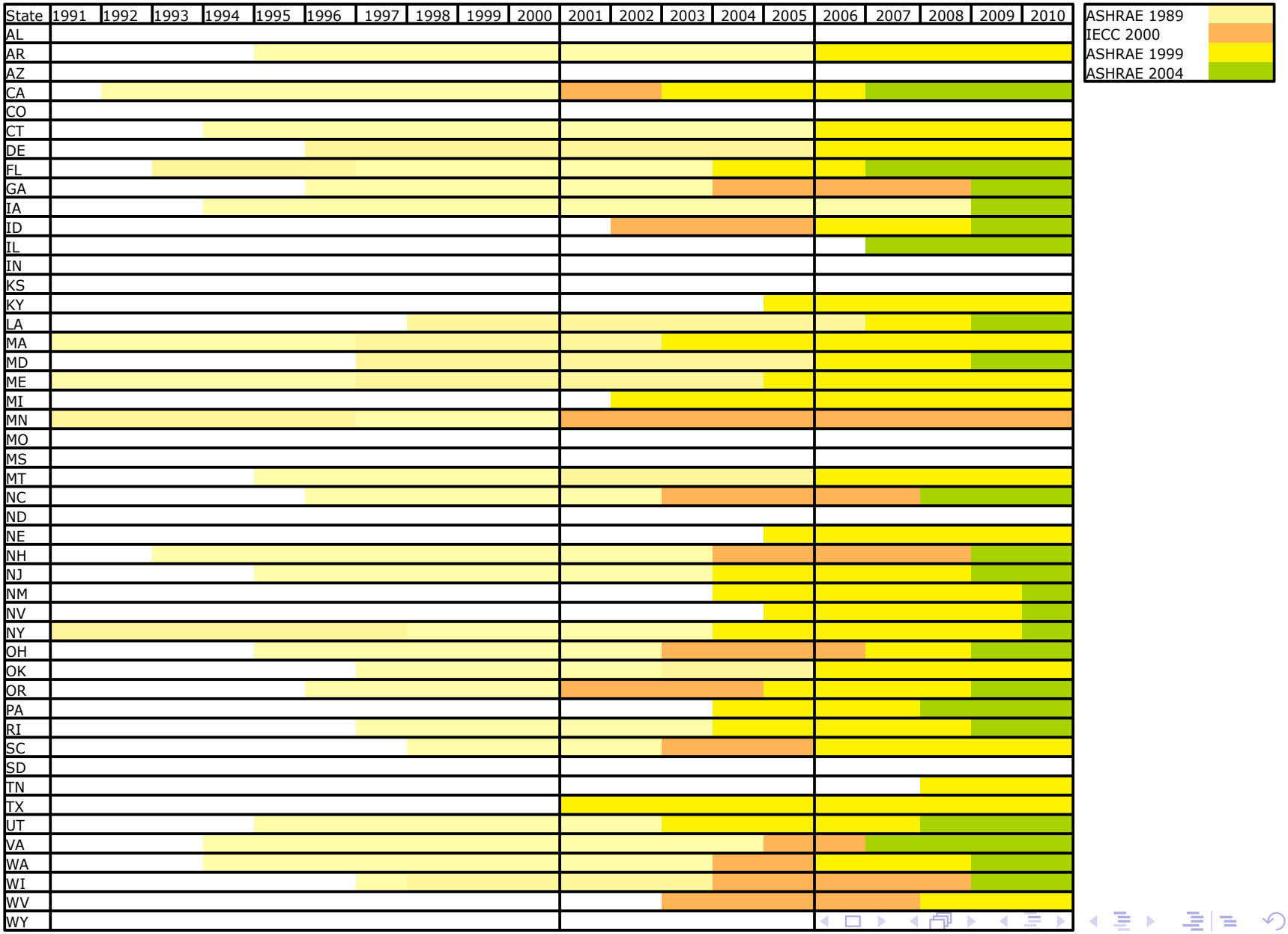
State
1991
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2010
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AR
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ID
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KS
KY
LA
MA
MD
ME
MI
MN
MO
MS
MT
NC
ND
NE
NH
NJ
NM
NV
NY
OH
OK
OR
PA
RI
SC
SD
TN
TX
UT
VA
WA
WI
WV
WY
ASHRAE 1989
IECC 2000
ASHRAE 1999
ASHRAE 2004

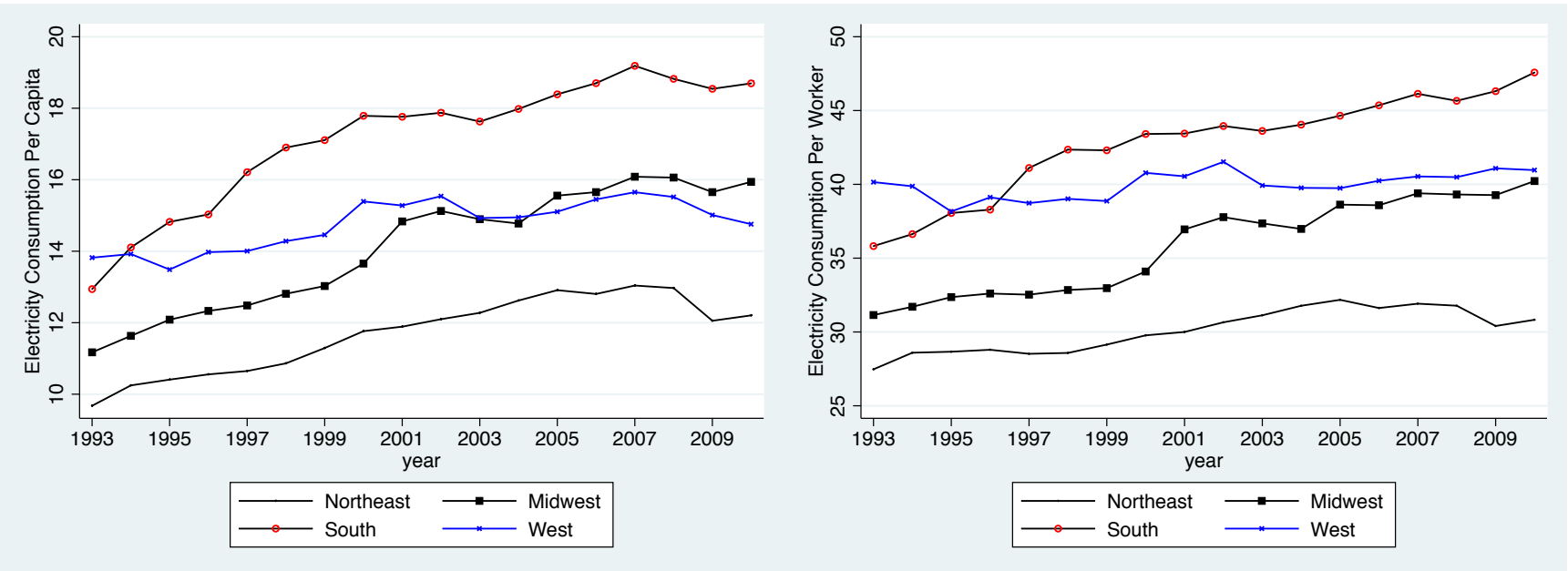
Results

Buildings constructed under a more stringent energy standard:

1. Rent for 6.5% more when tenants pay directly for utilities
2. Sell at a 8.8% premium
3. The premium is higher in hot, humid climates; lower in cool, low humidity climates

2. Utilities contracts and electricity consumption

Electricity consumption has been on an upward trend in most regions



Billion btu per person, billion btu per worker

2. Utilities contracts and electricity consumption

Whether tenants pay for their utility bills directly is thought to matter

- Kahn, Kok and Quigley (2014)
- Gillingham et al (2012)
- National Science and Technology Council (2011)
- Levinson and Niemann (2004)

Current literature focused mostly on small geographic areas

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Selected Post Energy Policy Act (1992) Adoptions

States induced to adopt a standard as a result of EPAct:

Connecticut (1994)
Iowa (1994)
Arkansas (1995)
Montana (1995)
New Jersey (1995)
Ohio (1995)
Utah (1995)
Delaware (1996)
Georgia (1996)
Texas (2001)
Idaho (2002)
Michigan (2002)
New Mexico (2004)
Pennsylvania (2004)
Kentucky (2005)
Nebraska (2005)
Nevada (2005)
Illinois (2007)

Data Sources

Energy Information Administration

- Commercial electricity consumption
- Electricity and natural gas prices
- Demand-side management

Building Codes Assistance Project

Census Bureau, Bureau of Labor Statistics, Bureau of Economic Analysis

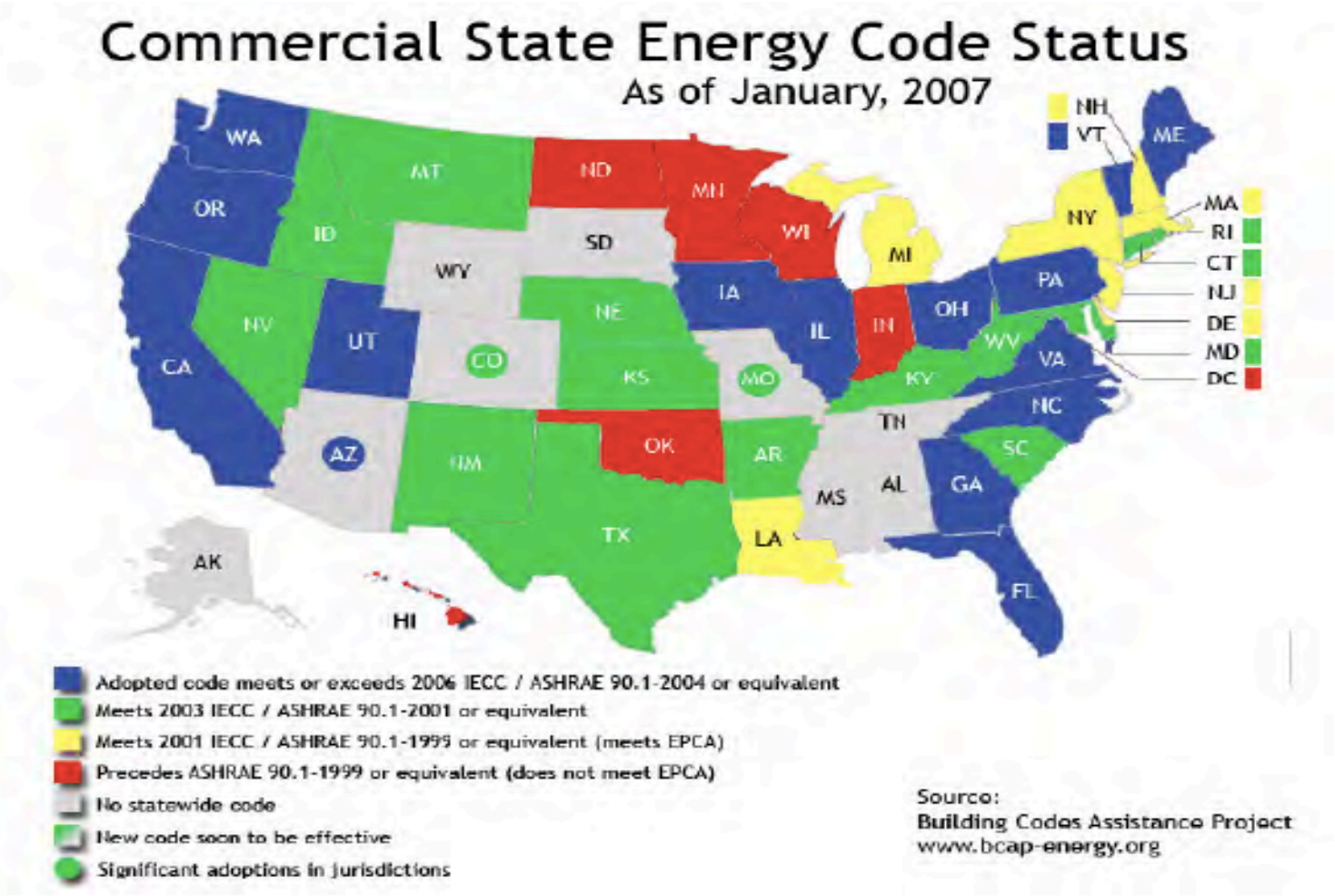
- Value of non-residential construction
- Producer price index
- Population

CoStar...

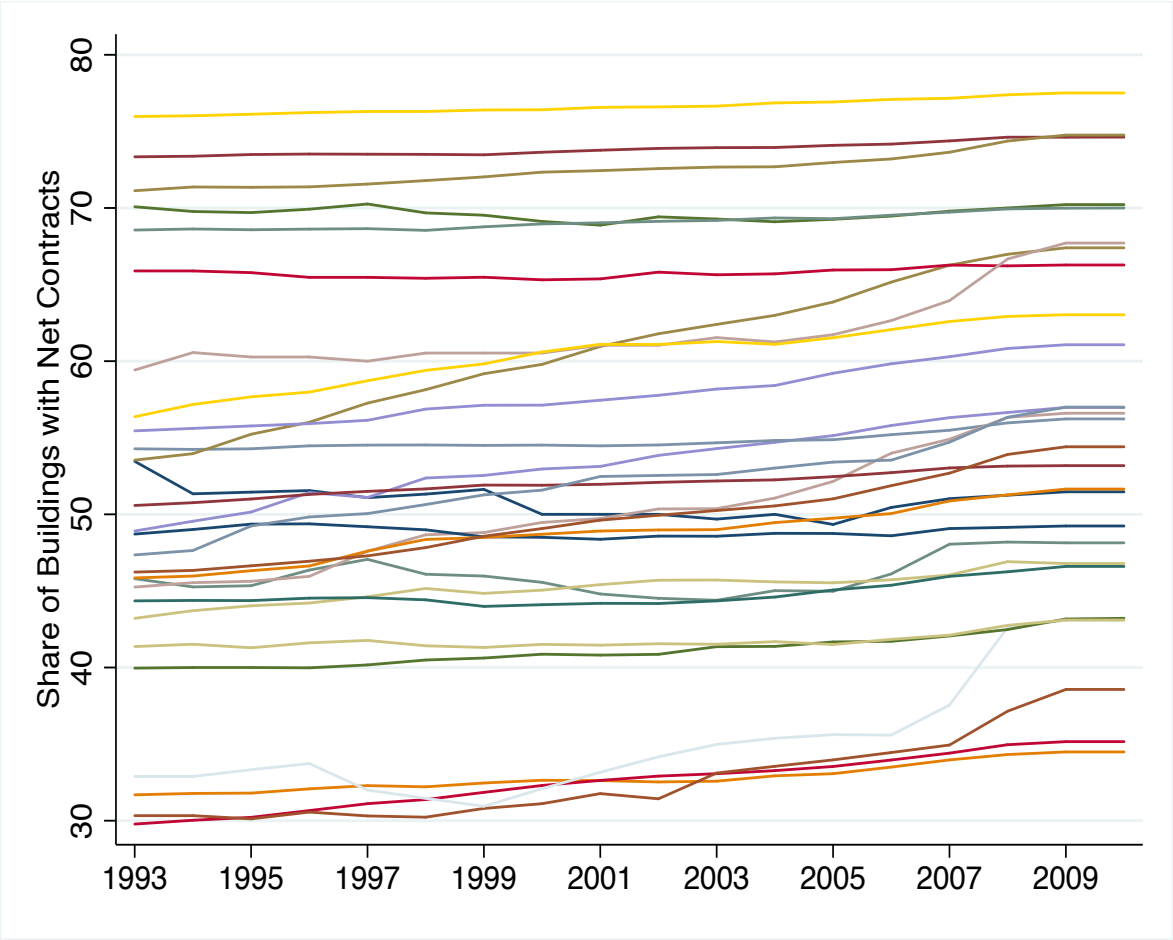
CoStar Data

Largest commercial building database ($>$ 1 million properties)

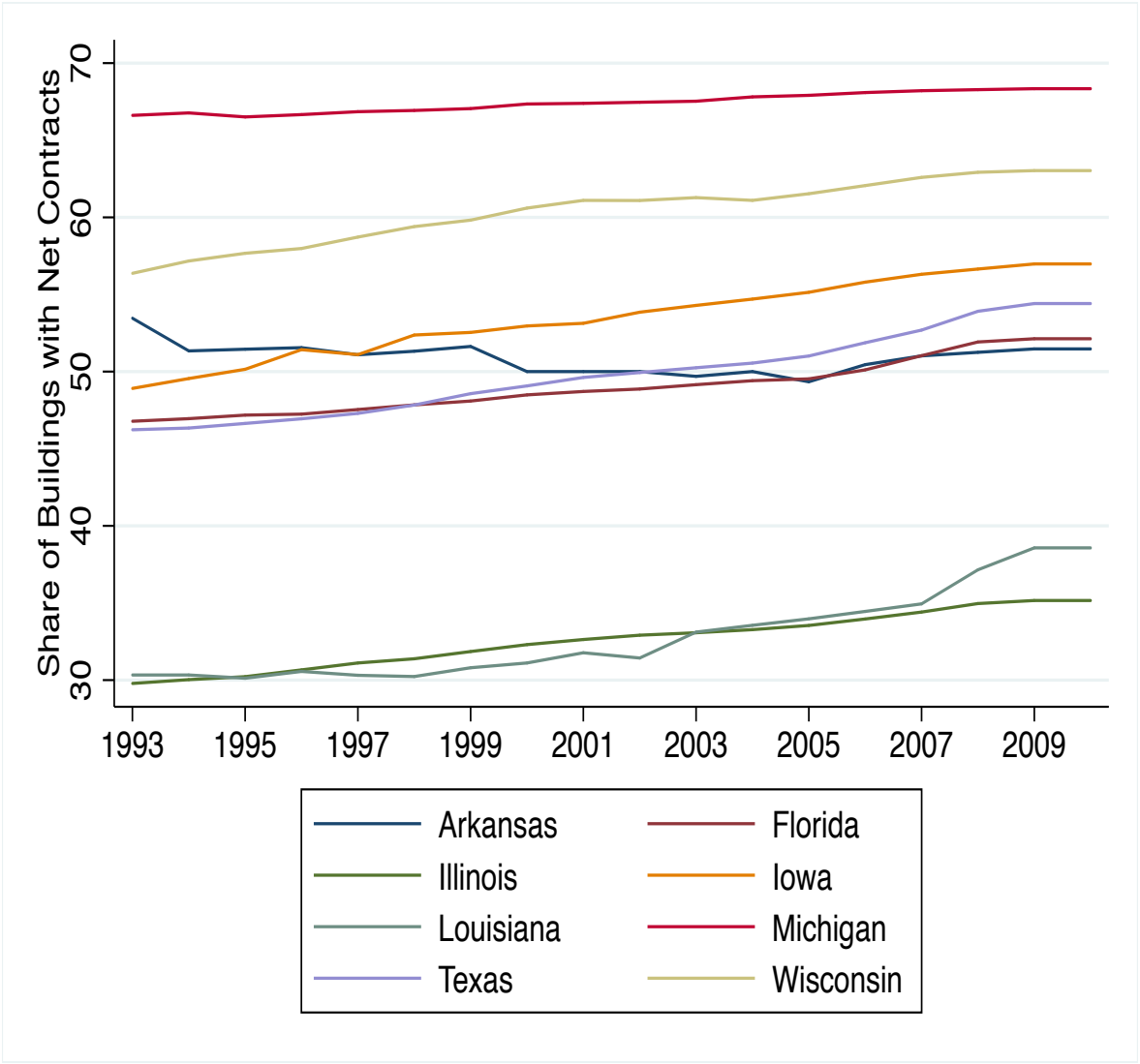
- Detailed hedonic characteristics
- Tenancy Contracts (185,000)
  - $\longrightarrow$ whether or not tenants pay for utilities


Commercial State Energy Code Status
As of January, 2007
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NE
KS
OK
TX
MN
IA
MO
AR
LA
WI
IL
MS
MI
IN
KY
TN
AL
OH
WV
GA
FL
SC
NC
VA
PA
NY
NH
VT
ME
MA
RI
CT
NJ
DE
MD
DC
AK
HI
Adopted code meets or exceeds 2006 IECC / ASHRAE 90.1-2004 or equivalent
Meets 2003 IECC / ASHRAE 90.1-2001 or equivalent
Meets 2001 IECC / ASHRAE 90.1-1999 or equivalent (meets EPCA)
Precedes ASHRAE 90.1-1999 or equivalent (does not meet EPCA)
No statewide code
New code soon to be effective
Significant adoptions in jurisdictions
Source:
Building Codes Assistance Project
www.bcap-energy.org

Variation in Net Contract Share



Variation in Net Contract Share



Results

- A one percentage point increase in the net contract rate is associated with a 1% decrease in per capita electricity consumption.

- Results are robust to controlling for DSM, compliance heterogeneity.

3. Property management, contract type, and electricity consumption

-Some evidence suggests property managers promote efficient use of electricity

- Kahn, Kok and Quigley (2014)
- Bloom et al (2011)

-Incorporating property management company may improve ability to explain variation in electricity consumption

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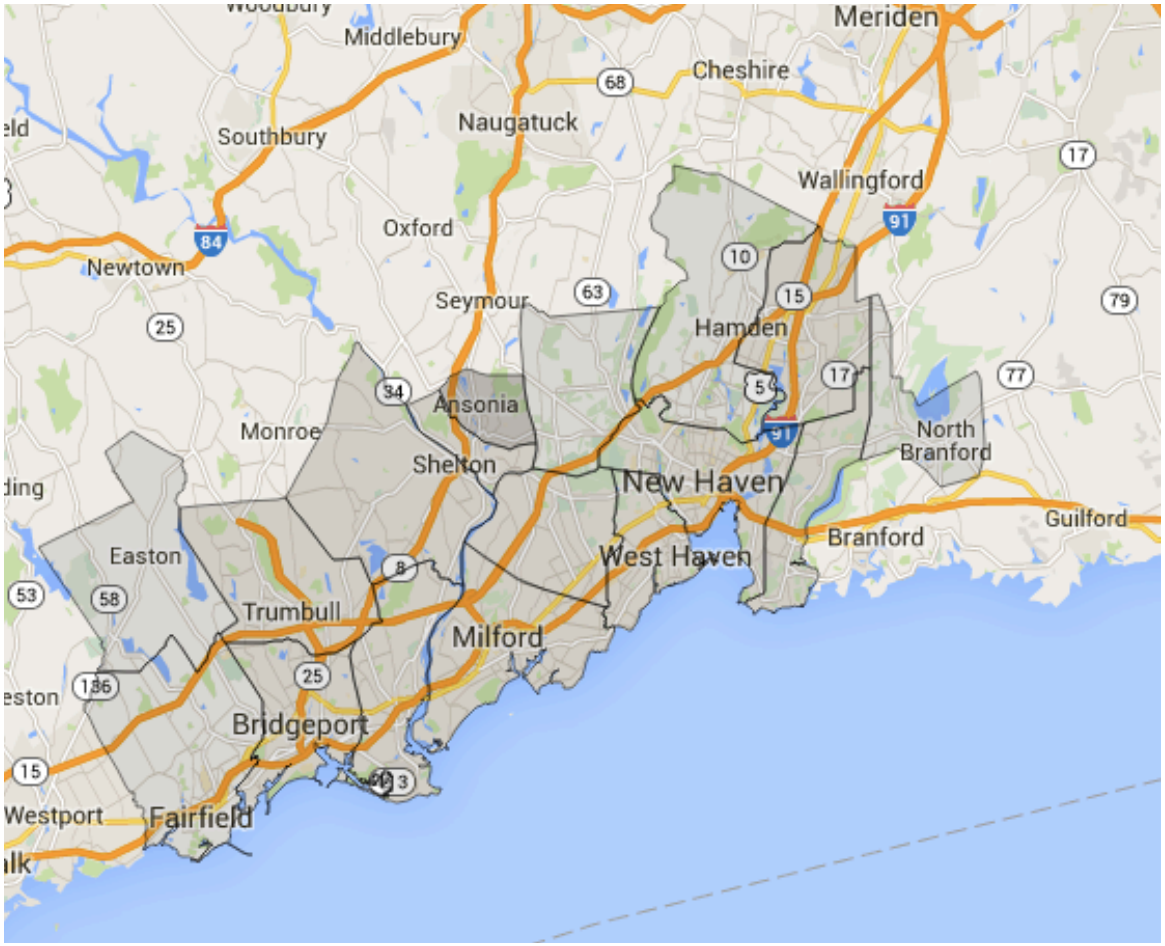
Data

-Monthly electricity consumption data from United Illuminating, Connecticut

-Contract type, leasing company, and building characteristics from CoStar

-1,456 accounts, Oct. 2007-May 2011

United Illuminating Service Territory



Results

- Tenants who pay for utilities reduce peak electricity consumption by about 2% for every unit increase in cooling degree days.*
  - → Their bills are also lower by about 2%.
  - → However, they don't reduce total electricity consumption, which suggests peak shifting.

- Contracts only make a difference when property management is controlled for.

- Explicit "green" management expertise does not significantly affect electricity consumption.

*CDD: # of degrees a month's average temperature is above 65F

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Conclusions

- Results suggest contract structure does affect electricity consumption
- In the commercial sector, tenants are willing to pay a premium for energy efficiency
- The mechanisms that affect landlord-tenant problems likely vary by sector (commercial/residential)
- Policies targeted towards addressing principal-agent problems need to be crafted to differentiate among heterogeneous sectors, since the magnitude of the inefficiency likely differs

Conclusions

Other market failures are also likely at play:

1. Property developers may undervalue energy efficiency when making investment decisions

2. Credit market failures, mortgage market failures

Thank You!

Questions are welcome

Why do 'utilities included' contracts persist?

benefits $>$ costs in many cases

- Levinson and Niemann (2004)

Submetering has been heavily regulated in some jurisdictions

- Connecticut (until July 2013)
- Arizona (until 2000)
- Georgia (until 2000)
- Oklahoma (until 1999)

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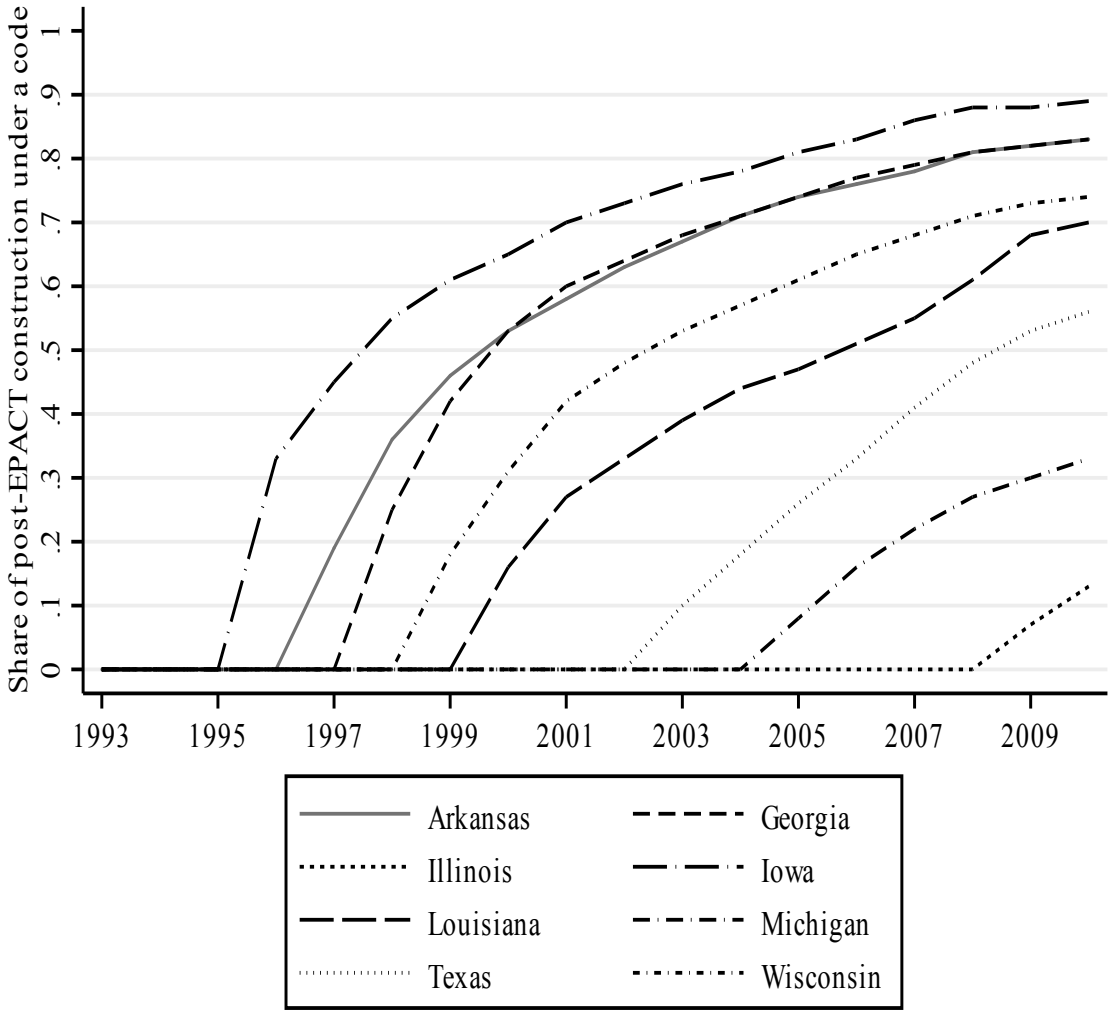
Why do 'utilities included' contracts persist?

Even when submetering is allowed, owners in most states cannot pass the costs onto tenants.

Exceptions:

- Utah
- Texas
- South Carolina
- Georgia

Variation in Value Share of Post-EPACT New Construction Value



Results: Asking rent

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample				Hot, Humid	Cool, Low Humidity
Code	0.0499***	0.0499***	0.0442***	0.0169	-0.0379	0.0624
	(0.0111)	(0.0162)	(0.0146)	(0.0204)	(0.0316)	(0.0607)
Utilities x Code				0.0654**	0.0939**	0.0378
				(0.0320)	(0.0414)	(0.0292)
Utilities				-0.160***	-0.1026**	-0.0922**
				(0.0269)	(0.0428)	(0.0126)
Fixed Effects	YES	YES	YES	YES	YES	YES
Covariates	NO	NO	YES	YES	YES	YES
Robust s.e.	YES	NO	NO	NO	NO	NO
Clustered s.e.	NO	YES	YES	YES	YES	YES
Observations	2,132	2,132	2,132	2,132	690	90
R-squared	0.65	0.65	0.70	0.70	0.71	0.92

Standard errors in parentheses. Clustered errors denotes clustering at the market level. *** p<0.01, ** p<0.05, * p<0.1.
Heterogeneity in the rent premium based on climate is reported in columns (5) and (6).

Results: Sales

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample				Hot, Humid	Cool, Low Humidity
Code	0.0987***	0.0979***	0.0882**	0.0812*	0.1034	-0.0438
	(0.0211)	(0.0269)	(0.0380)	(0.0417)	(0.0641)	(0.0889)
Code x Owner				0.0290		
				(0.0749)		
Owner-Occupied				0.0051		
				(0.0360)		
Fixed Effects	YES	YES	YES	YES	YES	YES
Covariates	NO	NO	YES	YES	YES	YES
Robust s.e.	YES	NO	NO	NO	NO	NO
Clustered s.e.	NO	YES	YES	YES	YES	YES
Observations	1,064	1,064	1,064	1,064	405	67
R-squared	0.65	0.65	0.68	0.68	0.65	0.93

Standard errors in parentheses. Clustered errors denotes clustering at the market level. *** p<0.01, ** p<0.05, * p<0.1.
Heterogeneity in the sales premium based on climate is reported in columns (5) and (6).

Results

	(1)	(2)	(3)	(4)	(5)
Electricity Price	-0.003	-0.004	-0.000	-0.008***	-0.025***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.008)
New Construction Share	-0.156***	-0.152***	-0.117**	-0.135***	-0.191***
	(0.059)	(0.057)	(0.049)	(0.034)	(0.077)
Net Contract Share		-0.011**	-0.011**	-0.012***	-0.023***
		(0.005)	(0.005)	(0.003)	(0.003)
Intensity			-0.058	-0.031	0.058
			(0.039)	(0.021)	(0.087)
DSM			-0.037**	-0.003	0.072***
			(0.012)	(0.011)	(0.025)
State Fixed Effects	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes
Price Instruments	Yes	Yes	Yes	Yes	Yes
H/L Intensity Lin. Trend	Yes	Yes	Yes	Yes	Yes
H/L Intensity Quad. Trend	Yes	Yes	Yes	Yes	Yes
R^2(within)	0.36	0.37	0.37	0.45	0.65
Observations:	522	522	522	774	252

Robust standard errors. *** p<0.01, ** p<0.05, * p<0.1.

Energy, utility cost savings

-Energy codes lead to $\approx$ 10% reduction in energy use per sq. ft.

$\longrightarrow$ similar to green-labeled building savings

-Energy bill in office buildings averages about \$3.36/sq.ft./yr.

- 10% reduction (\$0.34) represents:
  - 1.9% of average rent
  - 1.8% of average net operating income

▸ Cap.

Present Value of the Energy Savings: Rent

$$PV = S \sum_{n=0}^{L} [g/(1+\delta)]^n,$$

where
S= value of utility cost savings
g= growth rate of utility costs
δ= discount rate
L= contract length

If L=5, g=2%, δ=5.5%, Percent savings $\approx$ 2.5%
If L=5, g=3%, δ=7%, Percent savings $\approx$ 2.5%

go back

Present Value of the Energy Savings: Sales

$$PV = S \sum_{n=0}^{L} [(1+g)/(1+\delta)]^n,$$

where
S= value of utility cost savings
g= growth of utility costs
δ= discount rate
L= contract length

If L=5, g=2%, δ=10%, NOI=\$19, Percent savings $\approx$ 7%
If L=10, g=2%, δ=15%, NOI=\$30, Percent savings $\approx$ 10%

go back

Capitalization Equation

Market price of a commercial office building can be expressed as:

$$P_0 = \sum_{t=1}^{\infty} \frac{NOI_t}{(1+i_t)^t}$$

where

NOI = net operating income = income - operating expenses
P_0 = market price at purchase date
i_t = market interest rate

Back

Capitalization Equation

Assume:
Current *NOI* is sufficient statistic for future net income
Flat term structure

$$P_0 = \frac{NOI}{(i - g)}$$

where

g = growth rate for net operating income

Back

Next Steps

- Combine electricity savings with cost of energy standards to obtain a cost-effectiveness figure
- Suggestions are welcome...

The Landlord-Tenant Problem

Adverse selection frequently cited as leading to underinvestment in energy efficiency (Gillingham et. al., 2009)

- Energy efficiency is costly to observe
- Owners may have difficulty convincing prospective buyers/tenants
- Can lead to foregone net beneficial energy efficiency investments
- Underinvestment in energy efficiency relative to social optimum

Such problems estimated to affect 40-80% of energy use in buildings (IEA, 2007)

Factors Affecting the Variation in Post-EPAct Adoption Dates

Institutional Framework

- Legislative vs. Regulatory
- Number of steps and stakeholders in the process

Legal Delays

- Trade group litigation
- Challenges to Positive Benefit-Cost Claims